1982
Air Monitoring Report
City of Calgary

prepared by

AIR QUALITY CONTROL BRANCH

POLLUTION CONTROL DIVISION

ENVIRONMENTAL PROTECTION SERVICES

ALBERTA ENVIRONMENT

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SYNOPSIS

This report is an assessment of the ambient air quality in the city of Calgary for the 1982 report year. The assessment is based on the results of the monitoring of various air pollutants by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment from January 1, 1982 to December 31, 1982.

The emphasis is on comparing the data with the levels outlined in the Alberta Clean Air (Maximum Levels) Regulations and on assessing the data for trends.

The air quality indices--numerical indicators of air quality, which are based on readings of sulphur dioxide, ozone, carbon monoxide, suspended particulate matter, and nitrogen dioxide--are also discussed in this report. Generally, the air quality was in the 'good' index range.

Considering data from 1974 to 1982, no apparent significant trends were found for nitrogen dioxide and carbon monoxide at the downtown area monitoring station, or for soiling index at the residential area monitoring station. Upward trends were found for soiling index at both the downtown area monitoring station and the industrial area monitoring station. Downward trends were found for nitrogen dioxide at the residential area and the industrial area monitoring stations, for ozone at all three stations, and for carbon monoxide at the residential area and the industrial area monitoring stations.

CONTENTS

		Page
I.	INTRODUCTION	1
II.	THE AIR MONITORING NETWORK	2
III.	THE AIR MONITORING INSTRUMENTATION	5
IV.	AIR POLLUTANT DATA ANALYSES	7
	A. Introduction	7
	B. Trends	10
	C. Oxides of Nitrogen	19
	D. Ozone	23
	E. Carbon Monoxide	26
	F. Sulphur Dioxide	30
	G. Total Hydrocarbons	34
	H. Particulates	37
	1. Soiling Index	39
	2. High-Volume Sampler	42
	3. Total Dustfall	45
V.	INDEX OF THE QUALITY OF THE AIR (IQUA)	49
VI.	SUMMARY AND CONCLUSIONS	51
VII.	REFERENCES	53

I. INTRODUCTION

The Air Quality Control Branch of Alberta Environment operates an on-going program of ambient air monitoring in the city of Calgary. The objectives of this program are twofold: to provide data for the assessment of existing air quality; and to establish long-term trends in air quality. To achieve these goals, the Branch operates a comprehensive network of stations equipped to measure oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide, total hydrocarbons, particulates and total sulphation.

The report summarizes the results of the monitoring of these air pollutants from January 1, 1982 to December 31, 1982.

The data obtained during this report year are compared with the air quality Regulations, which stipulate the maximum permissible concentrations of contaminants in the ambient air, as listed in the Alberta Clean Air (Maximum Levels) Regulations.

The "Source and Emission Inventories" for the pollutants are also cited to provide information on the contribution of each major source (e.g. industry and motor vehicles) to the total emissions of each pollutant.

II. THE AIR MONITORING NETWORK

The network of air monitoring stations in the city of Calgary is comprised of two units: the continuous ambient air monitoring network, which collects data on oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons; and the static and intermittent air monitoring network, which samples total sulphation and particulates - soiling index, suspended particulate matter (high volume sampler) and total dustfall.

Figure 1 illustrates the locations of the three continuous air monitoring stations. The stations are designated CDMU, CRMU and CIMU. The designations refer to the general locations of the stations in the downtown, residential and industrial areas respectively. Table 1 lists the parameters that each station is equipped to monitor continuously and gives additional information about the stations.

The locations of the static and intermittent air monitoring stations are also shown in Figure 1. This network of stations is comprised of 28 exposure sites for measuring total sulphation and total dustfall and three sites for measuring soiling index and suspended particulate matter.

FIGURE 1

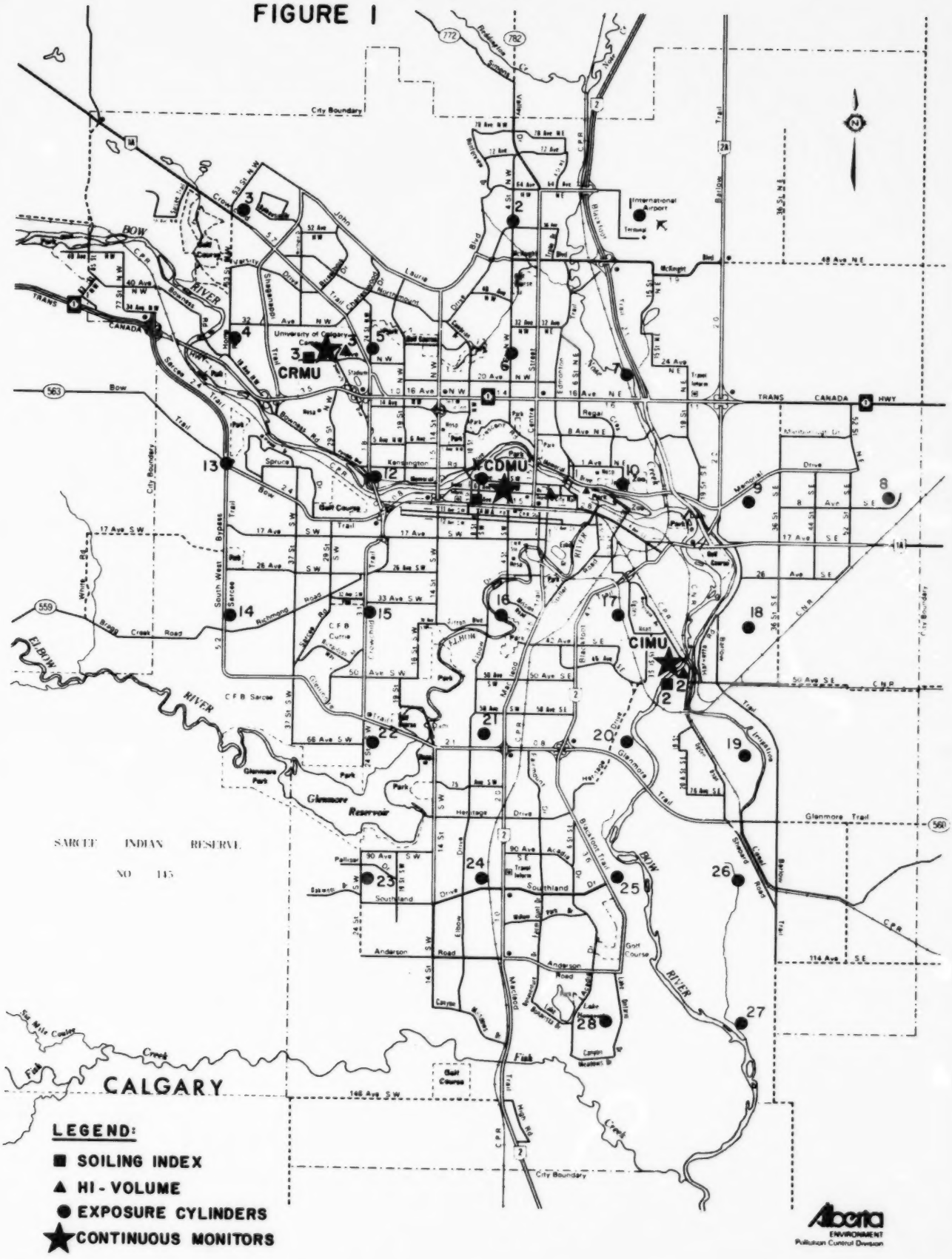
CRMU
CDMU
CIMU
CALGARY
SARCEE INDIAN RESERVE NO 145
City Boundary
Glenmore Reservoir
LEGEND:
SOILING INDEX
HI-VOLUME
EXPOSURE CYLINDERS
CONTINUOUS MONITORS
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TABLE 1

THE CONTINUOUS AMBIENT AIR MONITORING NETWORK

Parameters that Stations are Equipped to Monitor Continuously

Station	Wind	NO_x	NO_2	O_3	CO	SO_2	THC
CDMU	-	x	x	x	x	-	x
CIMU	x	x	x	x	x	x	x
CRMU	x	x	x	x	x	-	x

Note: CDMU - Calgary Downtown Monitoring Unit
CIMU - Calgary Industrial Monitoring Unit
CRMU - Calgary Residential Monitoring Unit

NO_x - Oxides of Nitrogen
NO_2 - Nitrogen Dioxide
O_3 - Ozone
CO - Carbon Monoxide
SO_2 - Sulphur Dioxide
THC - Total Hydrocarbons

Station Documentation

Station	Station Address	Height of Station	Height of Sample Inlet Above Ground
CDMU	4 St. and 6 Ave. S.W.	4 m	6 m
CIMU	18A St. and 45 Ave. S.E.	3 m	4 m
CRMU	39 St. and 29 Ave. N.W.	3 m	4 m

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III. THE AIR MONITORING INSTRUMENTATION

The detection principles and sampling periods of the pollutants monitored during the 1982 report year are presented in Table 2. Also included are the methods used to calibrate the instruments and the type of monitoring that was employed for each pollutant.

There are three basic types of ambient air monitoring, and they differ on the basis of the duration of the sampling periods: continuous, static and intermittent. Continuous monitoring is the sampling of the air on a continuous basis; static monitoring involves time periods of approximately 30 days; and intermittent monitoring encompasses 1-hour, 2-hour and 24-hour sampling time periods.

Monitoring of ambient air may also be categorized according to the method used for analyzing the sample, automatic or manual. Automatic analysis is accomplished by a system which has the capability of collecting the sample, analyzing it and giving a data read-out. This is exemplified by the monitoring of oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons. Manual analysis involves the collection of a sample and subsequent analysis at a laboratory. The monitoring of particulates and total sulphation are examples of the manual method.

TABLE 2

THE AIR MONITORING INSTRUMENTATION

Pollutant	Detection Principle	Sampling Period	Type of Monitoring	Instrument Calibration Method
Nitrogen Dioxide	Chemiluminescence	Instantaneous (sample integration)	Continuous	Gas phase titration or Certified gas cylinder
Ozone	Chemiluminescence or Ultraviolet photometry	Instantaneous (sample integration)	Continuous	Gas phase titration
Carbon Monoxide	Nondispersive infrared radiation	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Sulphur Dioxide	Coulometric detection or Pulsed fluorescence	Instantaneous (sample integration)	Continuous	Permeation tube
Total Hydrocarbons	Flame ionization	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Suspended Particulate Matter (Soiling Index)	Tape sampler (light transmittance)	1-hour or 2-hour	Intermittent	Rotameter - flow
Suspended Particulate Matter (High-Volume Sampler)	Gravimetry	24-hour	Intermittent	Orifice plates
Total Sulphation	Chemical reaction	30 days	Static	N/A
Total Dustfall	Gravimetry	30 days	Static	N/A

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IV. AIR POLLUTANT DATA ANALYSES

A. INTRODUCTION

In this section of the report, the pollutants are examined on an individual basis. The presentation includes general information on the pollutants, an overview of the prime emission sources as determined by the 1982 Source and Emission Inventory and an analysis of the data.

For the purposes of this report, the data are summarized. The summaries include arithmetic mean concentrations and the frequency of occurrence of concentrations in compliance with the Clean Air (Maximum Levels) Regulations.

Sufficient data must be available to constitute valid calculated mean values. When the instrument operational time is less than 50%, no arithmetic mean is calculated; and when the instrument is operational between 50% and 75% of the time, the arithmetic mean may not be representative of that period. Therefore, any comparisons of the data should take this into account.

Tables 3 and 4 are included to provide an overall picture of existing air quality and to give some idea of the trends of the air pollution levels over the past five years. A detailed look at trends is given in IV. B.

TABLE 3

POLLUTANTS COMPARED WITH CLEAN AIR REGULATIONS[1]

1982

POLLUTANT	PERCENT COMPLIANCE WITH REGULATIONS[1]			AIR QUALITY REGULATIONS
	CDMU	CIMU	CRMU	
Nitrogen Dioxide				
1-hour	99.99	99.98	100	0.21 ppm
24-hour	99.71	100	100	0.11 ppm
Ozone				
1-hour	99.99	99.99	99.88	0.080 ppm
24-hour	91.70	81.08	59.33	0.025 ppm
Carbon Monoxide				
1-hour	99.62	99.78	99.93	13.0 ppm
8-hour	98.54	99.07	99.64	5.0 ppm
Sulphur Dioxide				
1-hour	-	100	-	0.17 ppm
24-hour	-	100	-	0.06 ppm
Suspended Particulate Matter (Soiling Index-COH)	91.77	91.59	100	A minimum of 90% of readings per month shall be less than 1.0 COH.
Suspended Particulate Matter (High-Volume Sampler)	36.67	55.74	86.67	100 $\mu g/m^3$/24hr
Total Dustfall[2]				
Residential and Recreational Area Stations		73.44		53 mg/100 cm^2/30 days
Commercial and Industrial Area Stations		86.73		158 mg/100 cm^2/30 days

[1] Clean Air (Maximum Levels) Regulations.
[2] No allowance made for normal background levels as required by (1).

TABLE 4

ANNUAL CONCENTRATION MEANS IN CALGARY*
(1978-1982)

		1978	1979	1980	1981	1982
Nitrogen Dioxide (ppm)	CDMU	0.04	0.05	0.04	0.04	0.05
	CIMU	0.03	0.03	0.02	0.02	0.03
	CRMU	0.03	0.02	0.02	0.02	0.02
Ozone (ppm)	CDMU	0.014	0.013	0.012	0.010	0.012
	CIMU	0.012	0.018	0.013	0.012	0.016
	CRMU	0.022	0.023	0.021	0.020	0.022
Carbon Monoxide (ppm)	CDMU	2.7	2.8	2.3	2.3	2.0
	CIMU	1.5	1.5	1.4	2.0	1.4
	CRMU	1.1	1.2	1.0	1.1	1.0
Total Hydrocarbons (ppm)	CDMU	2.4	2.9	2.2	2.1	2.1
	CIMU	2.1	2.0	2.2	2.3	2.0
	CRMU	2.0	2.1	1.8	1.8	1.8
Total Sulphation 28 Stations (SO_3 equiv. mg/100cm^2/day)		0.16	0.15	0.24	0.21	0.14
Suspended Particulate Matter Soiling Index (COH Units)	CDMU	0.24	0.25	0.32	0.41	0.40
	CIMU	0.21	0.26	0.30	0.33	0.33
	CRMU	0.09	0.11	0.11	0.14	0.16
Suspended Particulate Matter High-Volume Sampler µg/m^3 (Geometric Mean)	CDMU	98	130	168	150	117
	CIMU	103	143	156	134	98
	CRMU	49	61	77	67	49
Total Dustfall						
Residential and Recreational Area Stations (17) mg/100 cm^2/30 days		56	58	65	63	48
Commercial and Industrial Area Stations (11) mg/100 cm^2/30 days		63	76	92	87	83

* For years 1978-1980 inclusive, means are based on climatic year (March of one year to February of the next year); from 1981 onwards, means are based on the calendar year.

B. TRENDS

Measurement uncertainties inherent in equipment, coupled with the variability of meteorological factors, the spatial variations of concentrations over a given area, and changes in the environment in proximity to the points of measurement, individually and collectively tend to obscure pollutant trends.

Preliminary analysis of each of the station histories indicated the data base was not entirely free of such problems. Whenever they occurred, such problem areas were deleted from the data base, pending further study.

For the preliminary work, the analytical approach chosen was to employ yearly means of nitrogen dioxide, ozone, carbon monoxide, and suspended particulate matter (coefficient of haze). The year to year variability of the data was reduced by using moving means given by:

$$\overline{Yi} = \frac{\text{summation of } Yj \text{ from } j = i - k \text{ to } i + k}{m}$$

$$\& \; k = \frac{m - 1}{2}$$

where $\overline{Yi}$ is the smoothed value

Yj is the original value

m is the length of the smoothing interval[1].

Three-year moving means were chosen (m=3), in part due to the number of available data points. Such a technique has been used in other air quality trend studies.[2] Summarized results are shown in Tables 5, 6, and 7 for CDMU, CRMU and CIMU respectively.

TABLE 5

YEARLY MEAN AND THREE-YEAR MOVING MEAN
POLLUTANT CONCENTRATIONS, 1974-1982

CALGARY
CDMU

YEAR	NITROGEN DIOXIDE		OZONE		CARBON MONOXIDE		COEFFICIENT OF HAZE (COH)	
	ARITHMETIC MEAN	3-YEAR MOVING MEAN	ARITHMETIC MEAN	3-YEAR MOVING MEAN	ARITHMETIC MEAN	3-YEAR MOVING MEAN	ARITHMETIC MEAN	3-YEAR MOVING MEAN
	(ppm)		(ppm)		(ppm)		(COH)	
1974	-	-	.0143	-	3.06	-	.315*	-
1975	.0280	-	.0163	.0143	2.73	2.63	.184	-
1976	.0317	.0346	.0123	.0133	2.11	2.40	.156	.176
1977	.0440	.0405	.0114	.0125	2.36	2.41	.188	.195
1978	.0458	.0455	.0137	.0128	2.77	2.66	.242	.225
1979	.0467	.0445	.0133	.0131	2.86	2.65	.246	.263
1980	.0409	.0411	.0124	.0120	2.34	2.51	.300	.318
1981	.0358	.0411	.0103	.0115	2.33	2.23	.408	.370
1982	.0467	-	.0117	-	2.01	-	.403	-

*-Omitted from the analysis pending verification.

TABLE 6

YEARLY MEAN AND THREE-YEAR MOVING MEAN
POLLUTANT CONCENTRATIONS, 1974-1982

CALGARY
CRMU

YEAR	NITROGEN DIOXIDE		OZONE		CARBON MONOXIDE		COEFFICIENT OF HAZE (COH)	
	ARITHMETIC MEAN	3-YEAR MOVING MEAN	ARITHMETIC MEAN	3-YEAR MOVING MEAN	ARITHMETIC MEAN	3-YEAR MOVING MEAN	ARITHMETIC MEAN	3-YEAR MOVING MEAN
	(ppm)		(ppm)		(ppm)		(COH)	
1974	-	-	.0250	-	1.54	-	.208	-
1975	.0400*	-	.0268	.0262	2.15	1.65	.181	.164
1976	.0160	-	.0269	.0250	1.25	1.59	.103	.132
1977	.0250	.0226	.0212	.0234	1.37	1.26	.112	.101
1978	.0267	.0247	.0222	.0223	1.17	1.20	.098	.104
1979	.0225	.0228	.0235	.0220	1.05	1.10	.101	.103
1980	.0192	.0200	.0204	.0213	1.08	1.06	.111	.117
1981	.0183	.0183	.0199	.0209	1.04	1.04	.140	.136
1982	.0175	-	.0223	-	0.99	-	.158	-

*-Omitted from the analysis pending verification.

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TABLE 7

YEARLY MEAN AND THREE-YEAR MOVING MEAN
POLLUTANT CONCENTRATIONS, 1974-1982

CALGARY
CIMU

YEAR	NITROGEN DIOXIDE		OZONE		CARBON MONOXIDE		COEFFICIENT OF HAZE (COH)	
	ARITHMETIC MEAN	3-YEAR MOVING MEAN (ppm)	ARITHMETIC MEAN	3-YEAR MOVING MEAN (ppm)	ARITHMETIC MEAN	3-YEAR MOVING MEAN (ppm)	ARITHMETIC MEAN	3-YEAR MOVING MEAN (COH)
1974	-	-	.0144	-	2.33	-	.250	-
1975	.0533*	-	.0186	.0172	2.22	2.11	.246	.234
1976	.0242	-	.0186	.0168	1.78	1.87	.205	.227
1977	.0309	.0289	.0132	.0145	1.60	1.63	.230	.219
1978	.0317	.0298	.0117	.0143	1.51	1.60	.223	.236
1979	.0267	.0278	.0179	.0145	1.68	1.48	.255	.254
1980	.0250	.0239	.0138	.0145	1.25	1.63	.285	.290
1981	.0200	.0250	.0117	.0139	1.96	1.53	.330	.316
1982	.0300	-	.0163	-	1.37	-	.334	-

*-Omitted from the analysis pending verification.

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In addition, plots of the three-year moving means were made (Figures 2, 3, 4, 5) for NO_2, O_3, CO, and COH. Trend lines for the three-year moving means were determined for each of the pollutants and COH, an example of which is shown in Figure 6 (for O_3 at CDMU).

Each of the trend lines was tested to see whether or not there was any significant trend over the period 1974 to 1982. The results of this analysis are shown in Table 8.

Considering data from 1974 to 1982, no apparent significant trends were found for nitrogen dioxide and carbon monoxide at CDMU, or for soiling index (coefficient of haze) at CRMU. Upward trends were found for soiling index (coefficient of haze) at both CDMU and CIMU. Downward trends were found for nitrogen dioxide at CRMU and CIMU, for ozone at all three stations, and for carbon monoxide at CRMU and CIMU.

Careful interpretation is required when examining the apparent trends, which are sensitive to the number of data points. Changes on a yearly basis are small, but all indicated slopes are significantly different from zero. However, it would be highly unlikely that any pollutant would continue a downward trend to zero concentration. Thus, these trends represent only the short-term conditions of 1974-1982 and are therefore mere snapshots in time of a larger, more complex situation.

FIGURE 2
THREE-YEAR MOVING MEAN OF YEARLY AVERAGE
NITROGEN DIOXIDE CONCENTRATIONS AT CALGARY
FOR THE PERIOD 1974 - 1982

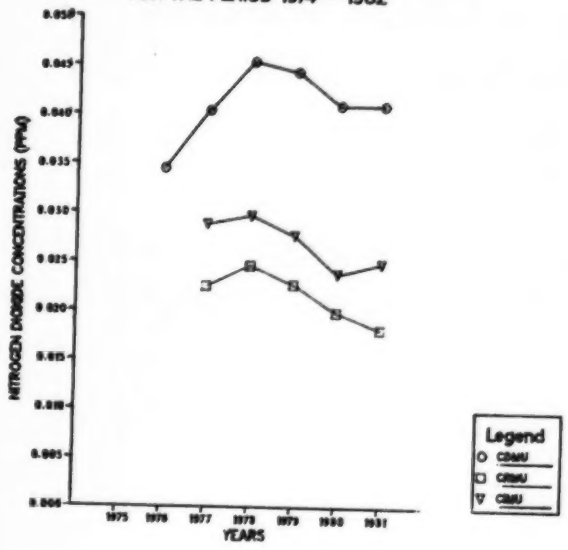

FIGURE 3
THREE-YEAR MOVING MEAN OF YEARLY AVERAGE
OZONE CONCENTRATIONS AT CALGARY
FOR THE PERIOD 1974 - 1982

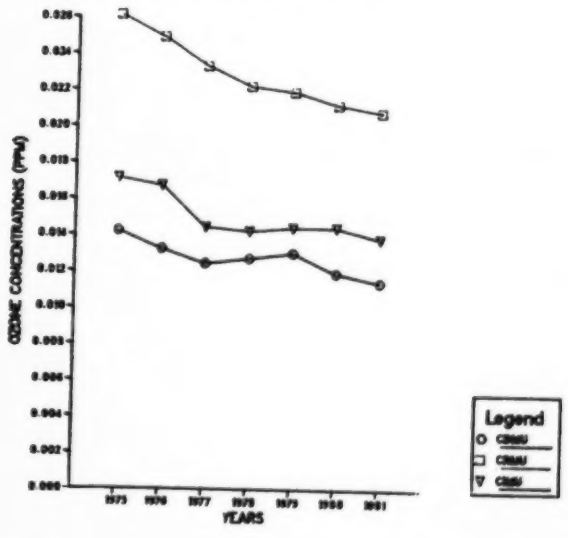

FIGURE 4
THREE-YEAR MOVING MEAN OF YEARLY AVERAGE CARBON MONOXIDE CONCENTRATIONS AT CALGARY FOR THE PERIOD 1974 – 1982

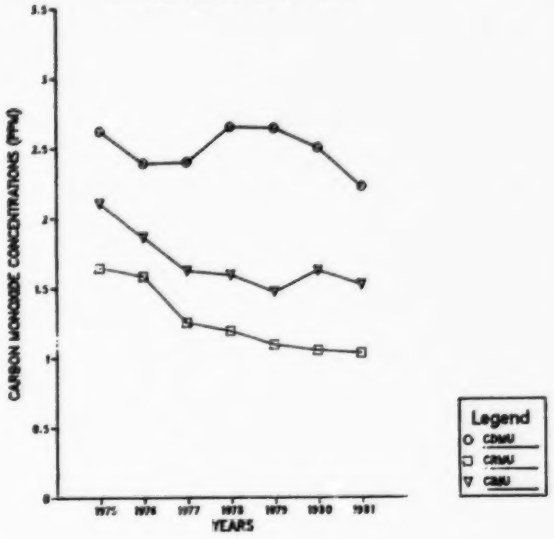

FIGURE 5
THREE-YEAR MOVING MEAN OF YEARLY AVERAGE COEFFICIENT OF HAZE READINGS AT CALGARY FOR THE PERIOD 1974 – 1982

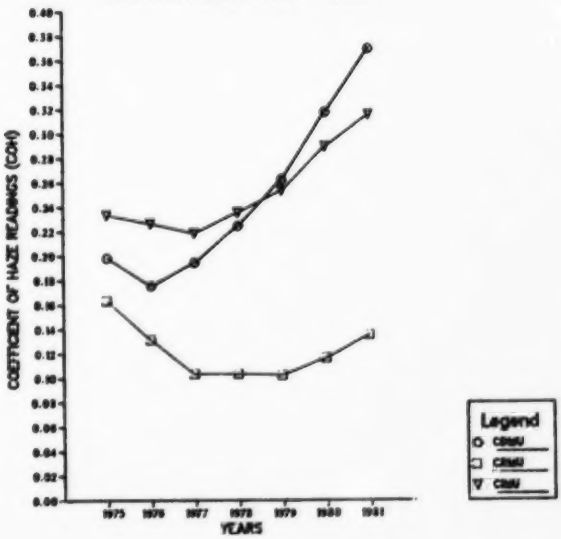

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FIGURE 6
THREE-YEAR MOVING MEAN OF YEARLY AVERAGE OZONE CONCENTRATIONS AT CDMU FOR THE PERIOD 1974 – 1982

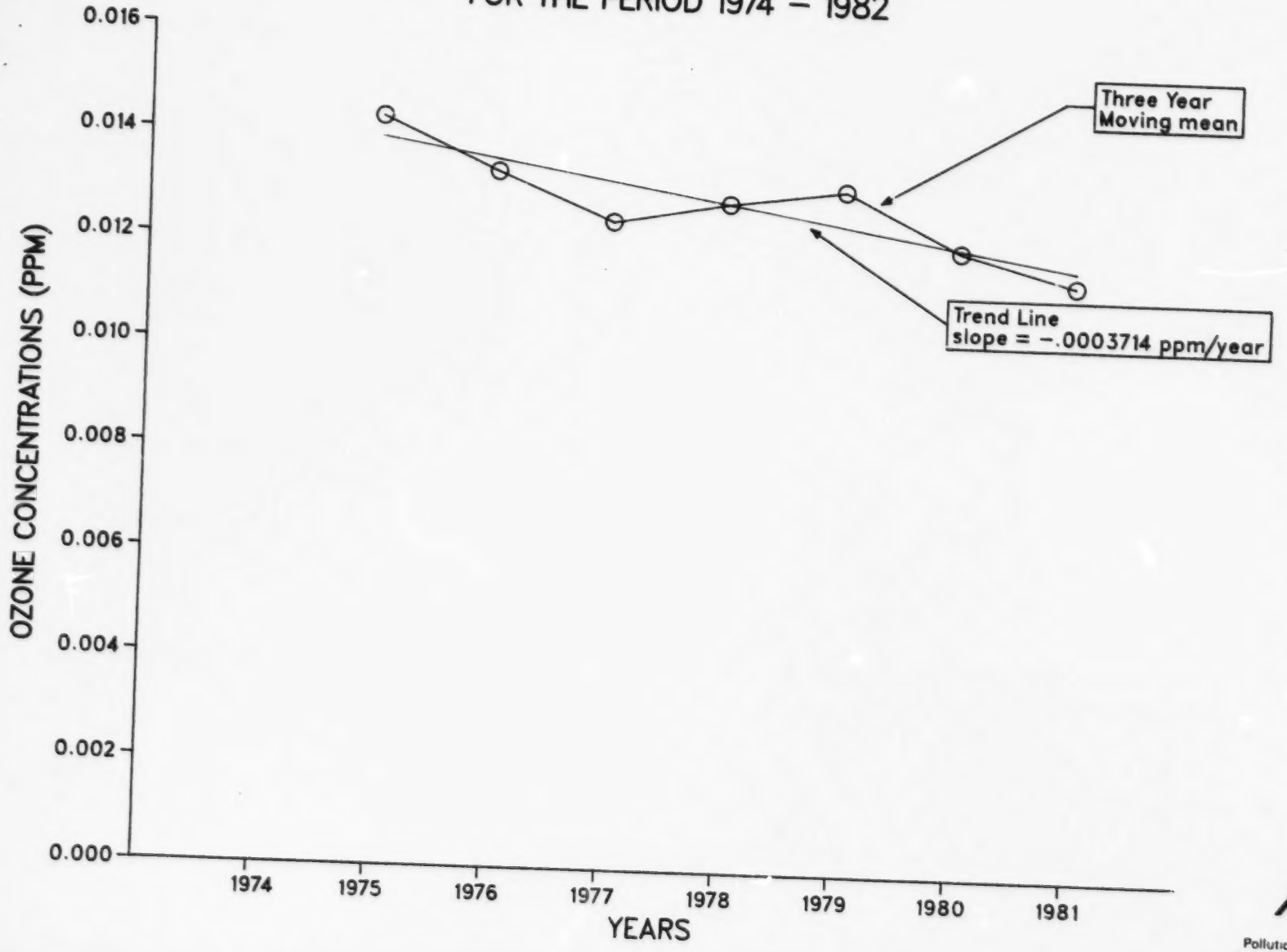

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TABLE 8
SUMMARY OF THREE-YEAR MOVING MEAN
TRENDS FOR POLLUTANTS AND COH
DURING THE PERIOD 1974-1982

CALGARY

	CDMU		CRMU		CIMU	
POLLUTANT	TREND CHARACTERISTICS	RATE OF CHANGE	TREND CHARACTERISTICS	RATE OF CHANGE	TREND CHARACTERISTICS	RATE OF CHANGE
Nitrogen Dioxide	no apparent significant trend		downward	-0.001330 ppm/yr	downward	-0.00134 ppm/yr
Ozone	downward	-0.0003714 ppm/yr	downward	-0.000882 ppm/yr	downward	-0.0005179 ppm/yr
Carbon Monoxide	no apparent significant trend		downward	-0.1089 ppm/yr	downward	-0.08464 ppm/yr
Coefficient of Haze	upward	0.03934 (COH Units)/yr	no apparent significant trend		upward	0.01451 (COH Units) /yr

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C. OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen are composed of two major constituents: nitrogen dioxide (NO_2) and the less toxic nitric oxide (NO). Both pollutants originate from natural and man-made processes. Nitrogen and oxygen, the principle constituents of the atmosphere, combine during high temperature combustion to form NO_x.[3] The major man-made source is from the burning of fossil fuels such as natural gas, coal, oil and gasoline.

In the city of Calgary, motor vehicles contribute 65.5 percent of the oxides of nitrogen emissions, natural gas combustion from sources such as home heating and commercial and light industry contributes 22.6 percent and industry contributes 7.2 percent. Smaller contributions are made by such sources as aircraft traffic (2.9%), railways (1.4%), and assorted minor contributors (0.4%). (Figure 7 - "Source and Emission Inventory").

The major oxide of nitrogen at the point of combustion is nitric oxide. A small fraction of the nitric oxide is converted to nitrogen dioxide by photochemical oxidation. Since it has been demonstrated that nitrogen dioxide can cause deleterious effects, and is the more toxic oxide of nitrogen, the emphasis here will be placed on nitrogen dioxide.

Nitrogen dioxide is an orange-brown gas with a characteristic pungent odour. Because of its colouration, it has been postulated that NO_2 is responsible for a portion of the brownish discolouration of air masses near urban areas.

The results of the monitoring of NO_2 during the 1982 report period are presented in Table 9 and Figure 7. All nitrogen dioxide readings were 100% in compliance with the Regulations, with the

exception of 99.9% compliance and 96.5% compliance in November with the 1-hour and 24-hour Regulations respectively at CDMU, and 99.9% compliance with the 1-hour Regulation at CIMU in November and December. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

On a seasonal basis, the NO_2 levels were generally lower during the summer and early fall at all three stations.

TABLE 9
NITROGEN DIOXIDE/OXIDES OF NITROGEN

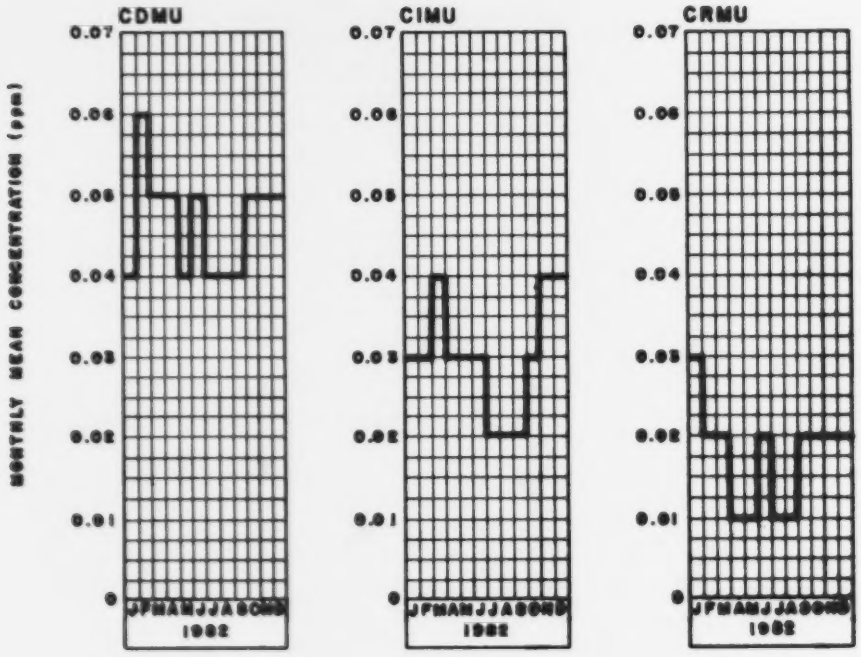
MAXIMUM LEVELS REGULATIONS(NO_2)
1-HOUR-0.21 PPM 24-HOUR-0.11 PPM

MONTH	ARITHMETIC MEAN (ppm)		PERCENTAGE OF TIME INSTRUMENT OPERATIONAL		PERCENT COMPLIANCE WITH NO_2 REGULATIONS	
	NO_2	NO_x	NO_2	NO_x	1-HR	24-HR
CDMU						
January '82	0.04	0.08	96.1	96.1	100	100
February	0.06	0.11	96.6	97.0	100	100
March	0.05	0.09	96.2	96.2	100	100
April	0.05	0.06	97.6	97.6	100	100
May	0.04	0.06	94.6	94.6	100	100
June	0.05	0.07	96.5	96.5	100	100
July	0.04	0.05	96.4	96.4	100	100
August	0.04	0.05	95.4	95.4	100	100
September	0.04	0.07	95.0	95.0	100	100
October	0.05	0.10	96.4	96.4	100	100
November	0.05	0.13	96.3	96.3	99.9	96.5
December	0.05	0.12	96.1	96.1	100	100
CIMU						
January '82	0.03	0.09	96.2	96.2	100	100
February	0.03	0.08	96.4	96.4	100	100
March	0.04	0.07	95.0	95.0	100	100
April	0.03	0.04	92.5	95.0	100	100
May	0.03	0.04	94.6	94.6	100	100
June	0.03	0.04	94.2	94.2	100	100
July	0.02	0.03	92.1	92.1	100	100
August	0.02	0.03	93.4	93.5	100	100
September	0.02	0.05	95.0	95.0	100	100
October	0.03	0.08	94.9	95.0	100	100
November	0.04	0.14	95.6	95.6	99.9	100
December	0.04	0.12	95.8	95.8	99.9	100
CRMU						
January '82	0.03	0.05	95.8	96.5	100	100
February	0.02	0.04	96.6	99.3	100	100
March	0.02	0.03	95.4	95.4	100	100
April	0.01	0.02	95.7	95.7	100	100
May	0.01	0.02	86.8	86.8	100	100
June	0.02[a]	0.02[a]	66.7	66.7	100	100
July	0.01	0.01	91.1	91.1	100	100
August	0.01	0.02	91.4	91.4	100	100
September	0.02	0.02	96.1	96.1	100	100
October	0.02[a]	0.03	51.6	87.6	100	100
November	0.02	0.05	92.5	92.5	100	100
December	0.02	0.05	93.4	93.4	100	100

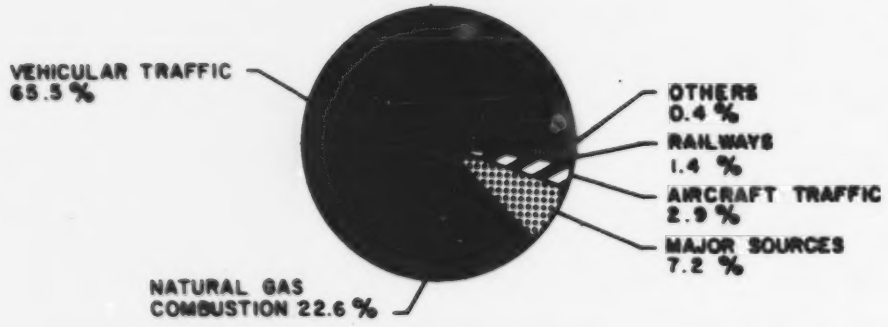
a - Instrument operational less than 75%; monthly mean may not be representative.

FIGURE 7 - OXIDES OF NITROGEN

NO_2 MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL OXIDES OF NITROGEN EMISSIONS IN THE CITY OF CALGARY, 1982

OXIDES OF NITROGEN
18059 tonnes

Alberta
ENVIRONMENT
Pollution Control Division

D. OZONE (O_3)

Unlike many other pollutants, ozone is not introduced directly to the air by man's activities. In the upper atmosphere, ozone is a naturally occurring constituent; in the lower atmosphere or ambient air, ozone is the primary end-product of photochemical oxidation involving the nitrogen oxides, ultraviolet light energy and reactive hydrocarbons. Ozone plays an important role in the absorption of harmful ultraviolet radiation in the upper atmosphere; however, in ambient air it can be harmful to humans, vegetation and various materials.

Table 10 and Figure 8 present a summary of the ozone data collected for this report year. The data indicate that:

1. The levels were generally highest during the spring and summer months at all three stations; and
2. The Clean Air (Maximum Levels) Regulation for the 24-hour period was exceeded during the spring and summer at CDMU and CIMU, and throughout the year at CRMU.

The frequent occurrence of readings in excess of the 24-hour Regulation is attributable to the high natural levels of ozone in Alberta constituting what is referred to as background levels.The background levels can fluctuate depending on environmental conditions and can exceed the 24-hour Regulation.[4]

The higher concentrations of ozone recorded at CRMU, relative to CDMU and CIMU, may not be indicative of local sources but may have resulted from wind transportation of the precursors to the residential area. The elevated readings in spring and summer are indicative of the increase in ultraviolet light energy, which enhances the photochemical production of ozone.

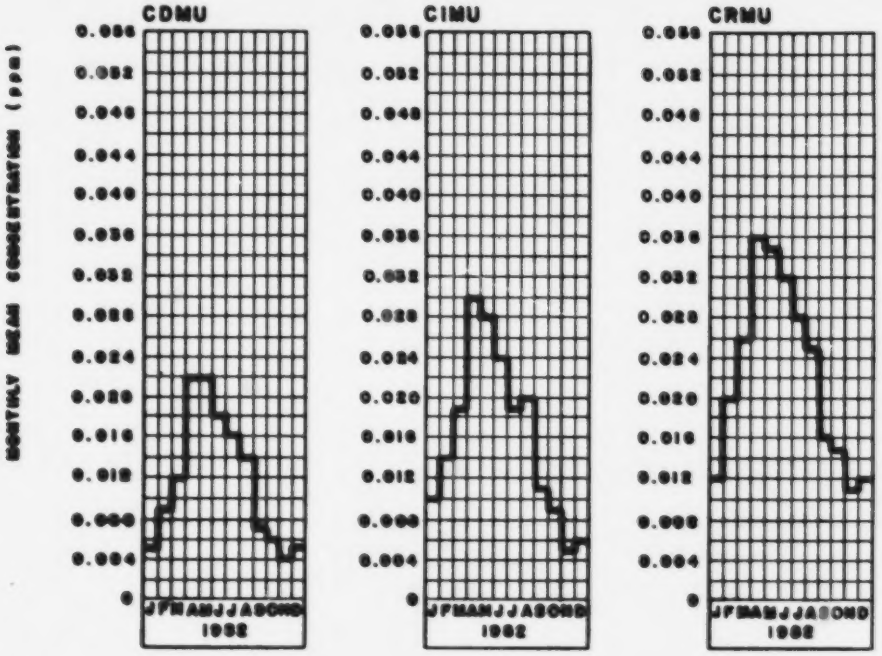
TABLE 10
OZONE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.080 PPM 24-HOUR-0.025 PPM

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
CDMU				
January '82	0.005	96.6	100	100
February	0.009	95.5	100	100
March	0.012	95.7	100	100
April	0.022	97.2	100	62.3
May	0.022	95.7	100	62.9
June	0.018	96.0	99.9	82.6
July	0.016	95.2	100	93.2
August	0.014	94.8	100	100
September	0.007	95.1	100	100
October	0.006	95.4	100	100
November	0.004	95.4	100	100
December	0.005	95.3	100	100
CIMU				
January '82	0.010	95.3	100	100
February	0.014	95.2	100	96.2
March	0.019	93.8	100	93.1
April	0.030	95.4	100	19.7
May	0.028	92.3	100	37.1
June	0.024	93.8	99.9	50.2
July	0.019	91.9	100	93.0
August	0.020	93.0	100	75.7
September	0.011	94.6	100	100
October	0.009	94.1	100	100
November	0.005	94.9	100	100
December	0.006	95.3	100	100
CRMU				
January '82	0.012	95.4	100	96.6
February	0.020	99.9	100	82.1
March	0.026	95.4	100	45.9
April	0.036	95.4	100	0.0
May	0.035	89.5	100	9.9
June	0.032	96.0	99.4	13.2
July	0.028	95.0	99.2	28.7
August	0.025	96.0	100	46.2
September	0.016	95.6	100	100
October	0.015	93.5	100	96.6
November	0.011	94.7	100	100
December	0.012	93.8	100	96.6

FIGURE 8 - OZONE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY

SINCE OZONE IS A NATURALLY OCCURRING AIR CONTAMINANT, AND IS ALSO A PRODUCT OF PHOTOCHEMICAL REACTION, THE SOURCE AND EMISSION INVENTORY IS NOT APPLICABLE.

E. CARBON MONOXIDE (CO)

Carbon monoxide is an odourless, colourless gas. It is emitted into the atmosphere in greater quantities than any other urban air pollutant. The majority of the carbon monoxide found in urban air comes from man-made sources. Natural sources, such as forest fires and plant decay, maintain a very low background level.

The 1982 "Source and Emission Inventory" for the city of Calgary (Figure 9) indicates that motor vehicles contribute almost all of the carbon monoxide; therefore, vehicle flow patterns do influence the monitored levels at individual stations.

There were averages of 99.8% compliance and 99.1% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

The generally higher carbon monoxide levels monitored at CDMU, relative to CIMU and CRMU, (Table 11 and Figure 9) are indicative of the vehicular traffic density in the downtown area. Diurnal variations of carbon monoxide levels indicate that peak levels occur during or immediately following peak rush hour periods. The data also indicate that the lowest CO concentrations were monitored during the spring and summer seasons at all three stations. This seasonal variation of CO levels results from changes in meteorological parameters. In the fall and winter, the colder ambient temperatures result in increased emissions of CO,

from motor vehicles, particularly during vehicle startups. In addition, the more stable atmospheric conditions and low wind speeds, which occur during the fall and winter, result in decreased dispersion of CO emissions and consequently higher ground level CO concentrations, relative to spring and summer concentrations.

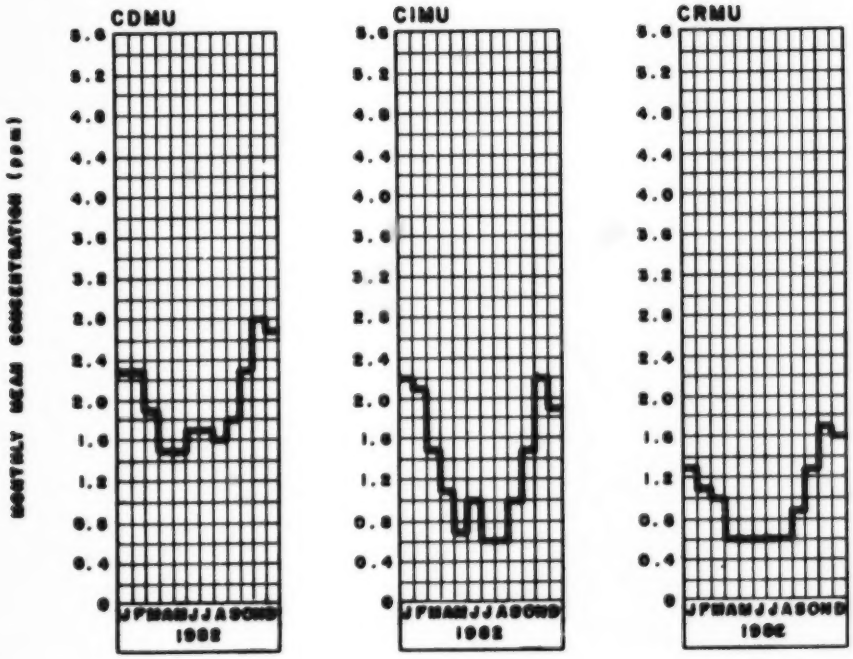
TABLE 11
CARBON MONOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-13 PPM 8-HOUR-5 PPM

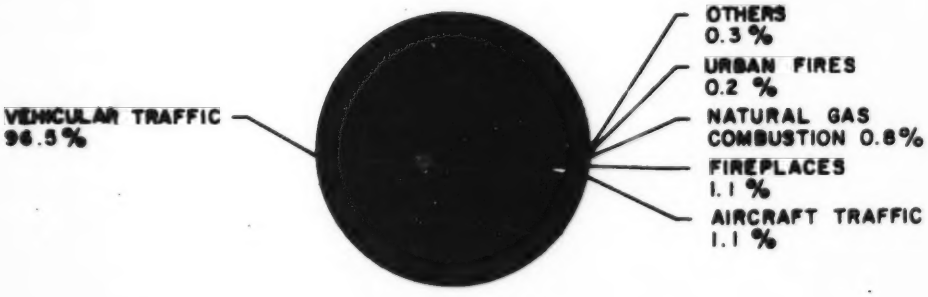
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	8-HR
CDMU				
January '82	2.3	91.1	98.8	94.1
February	2.3	92.7	99.4	92.3
March	1.9	97.3	99.9	98.9
April	1.5	98.1	100	100
May	1.5	96.5	100	100
June	1.7	97.4	100	100
July	1.7	96.8	100	100
August	1.6	95.8	100	100
September	1.8	95.8	100	98.2
October	2.3	97.2	99.4	96.7
November	2.8	97.2	99.0	87.4
December	2.7	97.0	98.9	84.5
CIMU				
January '82	2.2	96.4	99.4	94.4
February	2.1	95.5	99.2	96.3
March	1.5	92.5	99.9	97.7
April	1.1	96.1	100	100
May	0.7	95.7	100	100
June	1.0	94.9	100	100
July	0.6	93.4	100	100
August	0.6	96.4	100	100
September	1.0	95.7	100	100
October	1.5	95.3	99.7	98.9
November	2.2	95.6	99.4	88.4
December	1.9	96.5	99.7	94.4
CRMU				
January '82	1.3	96.8	100	98.9
February	1.1	100	99.7	98.8
March	1.0	96.5	100	100
April	0.6	97.4	100	100
May	0.6	90.2	100	100
June	0.6	96.8	100	100
July	0.6	96.8	100	100
August	0.6	97.4	100	100
September	0.9	96.5	100	100
October	1.3	94.5	99.7	98.9
November	1.7	95.4	99.9	95.3
December	1.6	94.5	99.9	96.6

FIGURE 9 - CARBON MONOXIDE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL CARBON MONOXIDE EMISSIONS IN THE CITY OF CALGARY, 1982

CARBON MONOXIDE
121358 tonnes

Alberta
ENVIRONMENT
Pollution Control Division

F. SULPHUR DIOXIDE (SO_2)

Sulphur dioxide constitutes one of the major air pollutants on a global basis. It may oxidize and combine with moisture to form sulphuric acid and, as such, increase its harmful effects on vegetation and the respiratory systems of humans and animals. When combined with particulate matter, it exerts a synergistic effect that is more harmful than the effect of either pollutant.

Sulphur dioxide pollution results primarily from man-made sources such as combustion of fossil fuels, smelting and roasting of sulphur containing ores, kraft and sulphite wood pulping and sour gas processing. In Alberta during 1982, an estimated 244 thousand metric tons of sulphur were emitted into the atmosphere from man-made (primarily industrial operations) sources. About 46 percent of the sulphur emissions was contributed by sulphur extraction plants; oil sands plants and power plants contributed about 25 percent and 14 percent respectively. The remaining 15 percent came from sources such as gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.[5]

A summary of the sulphur dioxide data collected during the 1982 report period is presented in Table 12. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

Figure 10 illustrates the SO_2 "Source and Emission Inventory" for the Calgary area and includes a graph of total sulphation levels. Although the total sulphation cylinders are static monitors and yield only monthly average values, the data do provide valuable trend information and, therefore, are included in this section.

As of January 1, 1982, SO_2 monitoring was conducted only at the industrial station in Calgary (CIMU), as both the downtown and residential stations consistently recorded readings of zero or slightly above.

The lowest total sulphation levels of the period occurred in June and July (0.11 mg. SO_3 equiv./day/100 sq. cm.), with the highest levels occurring in November (0.24 mg SO_3 equiv./day/100 sq. cm.). All monthly mean concentration levels were below the 0.5 mg. SO_3 equiv./day/100 sq. cm. guideline (Figure 10).

TABLE 12
SULPHUR DIOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.17 PPM 24-HOUR-0.06 PPM

CIMU

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
January '82	0.00	94.6	100	100
February	0.01	94.5	100	100
March	0.00	94.5	100	100
April	0.00	95.1	100	100
May	0.00	92.3	100	100
June	0.00	91.3	100	100
July	0.00	91.5	100	100
August	0.00	94.0	100	100
September	0.00	94.4	100	100
October	0.01	94.0	100	100
November	0.01	91.8	100	100
December	0.00	94.6	100	100

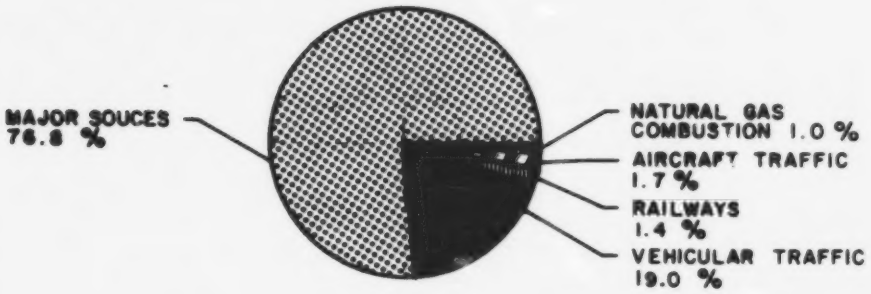
Alberta
ENVIRONMENT
Pollution Control Division
Air Quality Control Branch

FIGURE 10- SULPHUR DIOXIDE

NOTE

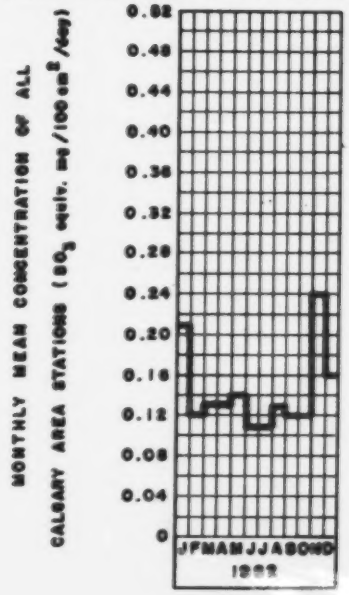
THE MONTHLY MEAN CONCENTRATIONS WERE LESS THAN OR EQUAL TO 0.01 ppm THROUGHOUT THE REPORT YEAR.

SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL SULPHUR DIOXIDE EMISSIONS IN THE CITY OF CALGARY, 1982	SULPHUR DIOXIDE 2769 tonnes

MONTHLY MEAN TOTAL SULPHATION LEVELS



Alberta ENVIRONMENT Pollution Control Division

G. TOTAL HYDROCARBONS (THC)

The hydrocarbons considered in this section are those which exist in the atmosphere in the gaseous phase. They are important because they are precursors of compounds formed in the atmospheric photochemical system. Therefore, any assessment of the effects of hydrocarbon pollution must be made in relation to the effects of photochemical air pollution.

The natural sources of the gas-phase hydrocarbons, of which methane is a major constituent, include trees and vegetation. For man-made sources, the "Source and Emission Inventory" (Figure 11) indicates that in Calgary motor vehicles are the primary source (59.1%), followed by gasoline marketing (31.2%), dry cleaning (3.0%), and fireplaces (2.0%). Smaller contributions are made by sources such as natural gas combustion (1.9%), aircraft traffic (1.5%), urban fires (0.8%), and other causes (0.1%). The motor vehicle emissions result from inefficient combustion. Inefficient combustion, which occurs before the vehicle reaches operating temperature, is particularly evident during the winter.

The levels of total hydrocarbons monitored during this report period (Table 13 and Figure 11) were generally lowest at the residential station, CRMU. On a seasonal basis, the highest total hydrocarbon levels were usually monitored during the fall and winter months and the lowest during the spring and summer months.

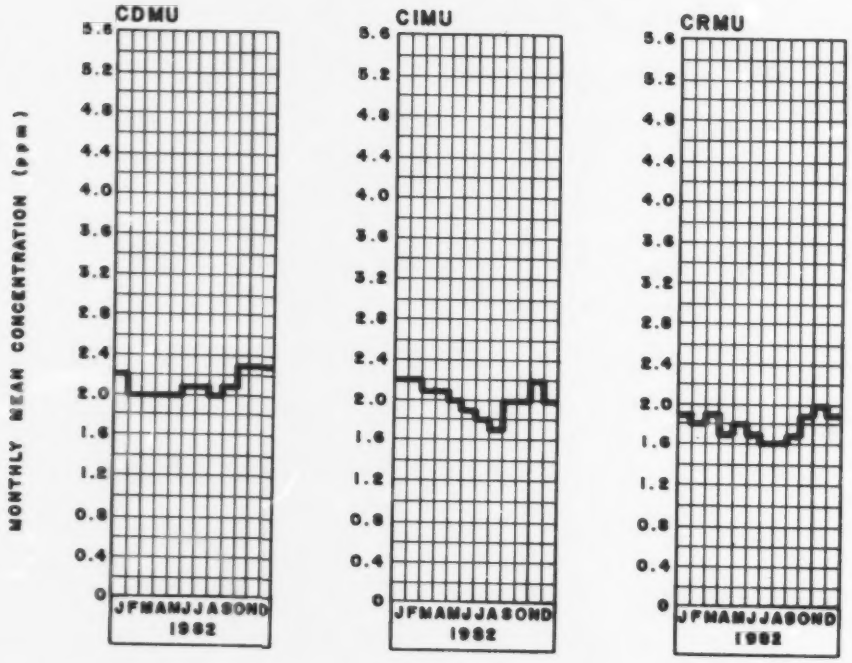
Currently there are no air quality Regulations for hydrocarbons.

TABLE 13
TOTAL HYDROCARBONS

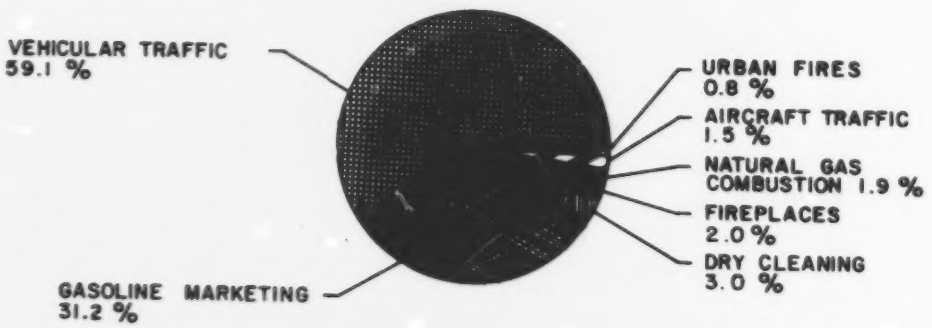
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
		CDMU		
January '82	2.2	97.8	NO REGULATION	
February	2.0	97.0		
March	2.0	97.2		
April	2.0	95.1		
May	2.0	96.6		
June	2.1	97.4		
July	2.1	85.8		
August	2.0	88.0		
September	2.1	96.4		
October	2.3	97.2		
November	2.3	83.9		
December	2.3	97.2		
		CIMU		
January '82	2.2	96.8	NO REGULATION	
February	2.2	97.2		
March	2.1	96.2		
April	2.1	96.1		
May	2.0	93.5		
June	1.9	94.3		
July	1.8	92.9		
August	1.7	84.8		
September	2.0	95.6		
October	2.0	95.7		
November	2.2	96.0		
December	2.0	96.2		
		CRMU		
January '82	1.9	97.0	NO REGULATION	
February	1.8	100		
March	1.9	97.2		
April	1.7	97.2		
May	1.8	90.3		
June	1.7	96.0		
July	1.6	87.8		
August	1.6	95.0		
September	1.7	96.7		
October	1.9	91.0		
November	2.0	96.3		
December	1.9	95.7		

FIGURE II - TOTAL HYDROCARBONS

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL HYDROCARBON EMISSIONS IN THE CITY OF CALGARY, 1982

HYDROCARBONS
16908 tonnes

OTHERS
MAJOR SOURCES 0.05 %
RAILWAYS 0.05 %
INCINERATORS 0.01 %
MINOR SOURCES 0.01 %

Alberta
ENVIRONMENT
Pollution Control Division

H. PARTICULATES

Particulate matter is composed of a wide variety of substances and encompasses any matter dispersed in the air where the individual particles are smaller in diameter than 500 microns (μ). It is the most commonly perceived form of pollution, often manifesting itself by interference with visibility, a soiling effect on materials or as a respiratory irritant. The characteristics of particles and particle dispersion are shown in Figure 12.

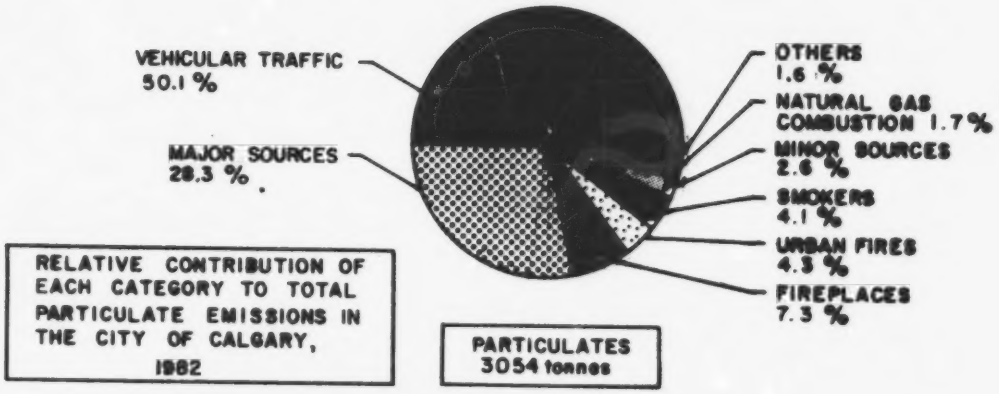
The "Source and Emission Inventory" (Figure 12) indicates that vehicular traffic is the primary source of particulate emissions, (50.1%), with major industrial sources contributing 28.3 percent. Dust from sources such as wind erosion and construction activities is not included in this inventory, although it may in fact be the greatest overall source.

In the city of Calgary, three types of sampling units are employed to measure particulate matter; therefore, the results for each type will be discussed separately in subsequent sections. The three types of samplers are the tape sampler, the high-volume sampler and the dustfall cylinder. The first two samplers measure suspended particulate matter while the latter measures total dustfall.

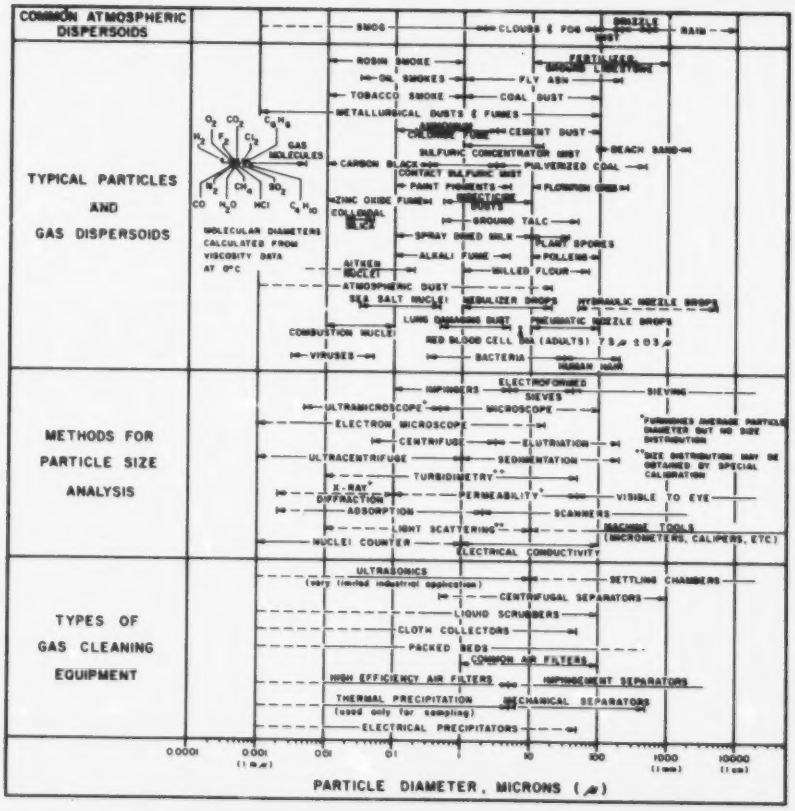
In general, particles smaller than 1 μ in diameter originate in the atmosphere, principally through condensation and combustion. Particles between 1 μ and 10 μ in diameter usually include soil, process dusts and combustion products from industries. Particles larger than 10 μ in diameter generally result from mechanical processes such as wind erosion, grinding, spraying and the pulverizing of materials by vehicles and pedestrians.[6]

FIGURE 12 - TOTAL PARTICULATES

SOURCE AND EMISSION INVENTORY



CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSION



H. 1. SOILING INDEX

Soiling index is the usual index of suspended particulate matter in the size range of 0.1 μ to 10 μ. It is not a measure of absolute concentrations as the method of analysis does not measure the deposited mass.

The types of suspended particulate matter identified as soiling index include smoke and fine dust particles. The samples are collected by drawing sample air through a filter paper over sampling cycles of one or two hours. The soiling properties of the sample are measured by the reduction of light transmission through the filter paper. This reduction is reported as a coefficient of haze (COH) per 1,000 linear feet of air sampled.

The soiling indices for this report year are summarized in Table 14. The provincial air quality guideline, that at least 90 percent of the readings per month should be less than 1.0 COH units, was complied with by all stations during the report period, except at CDMU and CIMU in November, 1982. The lowest average levels were generally recorded during the spring and summer months with CRMU recording the lowest levels (Figure 13).

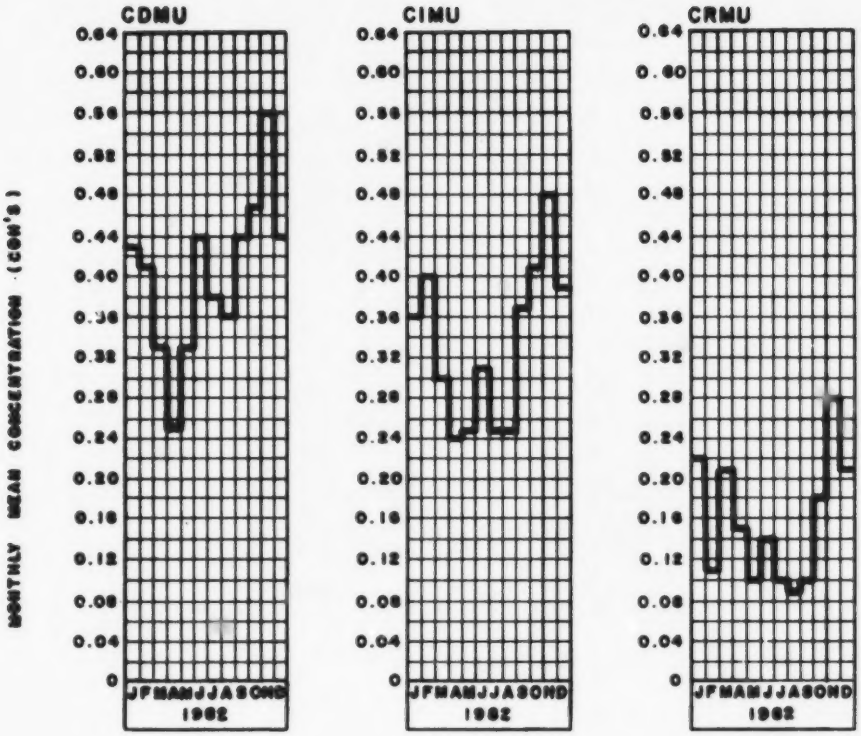
TABLE 14
SUSPENDED PARTICULATE MATTER/SOILING INDEX

GUIDELINE FOR SOILING INDEX
MINIMUM OF 90% OF READINGS PER MONTH
SHALL BE LESS THAN 1.0 COH

MONTH	ARITHMETIC MEAN (COH)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT OF READINGS LESS THAN 1.0 COH
		CDMU	
January '82	0.43	100	94.5
February	0.41	100	95.4
March	0.33	100	98.1
April	0.25	100	98.9
May	0.33	99.5	97.8
June	0.44	100	95.1
July	0.38	100	96.5
August	0.36	99.3	97.2
September	0.44	100	91.9
October	0.47	99.1	91.7
November	0.56	100	85.6
December	0.44	100	91.1
		CIMU	
January '82	0.36	99.6	94.3
February	0.40	97.2	92.2
March	0.30	96.0	97.9
April	0.24	98.8	98.6
May	0.25	99.9	98.7
June	0.31	94.0	96.9
July	0.25	94.4	99.1
August	0.25	98.8	98.6
September	0.37	96.3	93.2
October	0.41	91.3	93.2
November	0.48	99.3	89.4
December	0.39	99.6	93.4
		CRMU	
January '82	0.22	83.9	98.9
February	0.11	100	99.4
March	0.21	100	99.2
April	0.15	100	99.7
May	0.10	91.5	100
June	0.14	92.2	99.8
July	0.10	100	100
August	0.09	100	100
September	0.10	98.6	100
October	0.18	98.9	98.4
November	0.28	99.6	92.9
December	0.21	98.5	96.9

FIGURE 13 - SOILING INDEX

MONTHLY MEANS



Alberta
ENVIRONMENT
Pollution Control Division

H. 2. HIGH-VOLUME SAMPLER

Suspended particulate matter is also measured by the high-volume sampler. The sampler consists of a vacuum system and filter housed in a shelter. Suspended particulate matter in the atmosphere is determined by collecting 24-hour samples on the pre-weighed filter. The filter is then reweighed to determine the mass of the particles collected. This method gives a more accurate measurement of suspended particulate matter than the soiling index monitor.

The size of particles collected by the high-volume sampler range from 0.1 μ to 10 μ.

The levels of suspended particulate matter measured by the high-volume sampler (Table 15 and Figure 14) were occasionally in excess of the Clean Air (Maximum Levels) Regulation of 100 $\mu g/m^3$/24-hour at all three stations.

There was an average of 59.7% compliance achieved with the Regulation for suspended particulate matter, averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

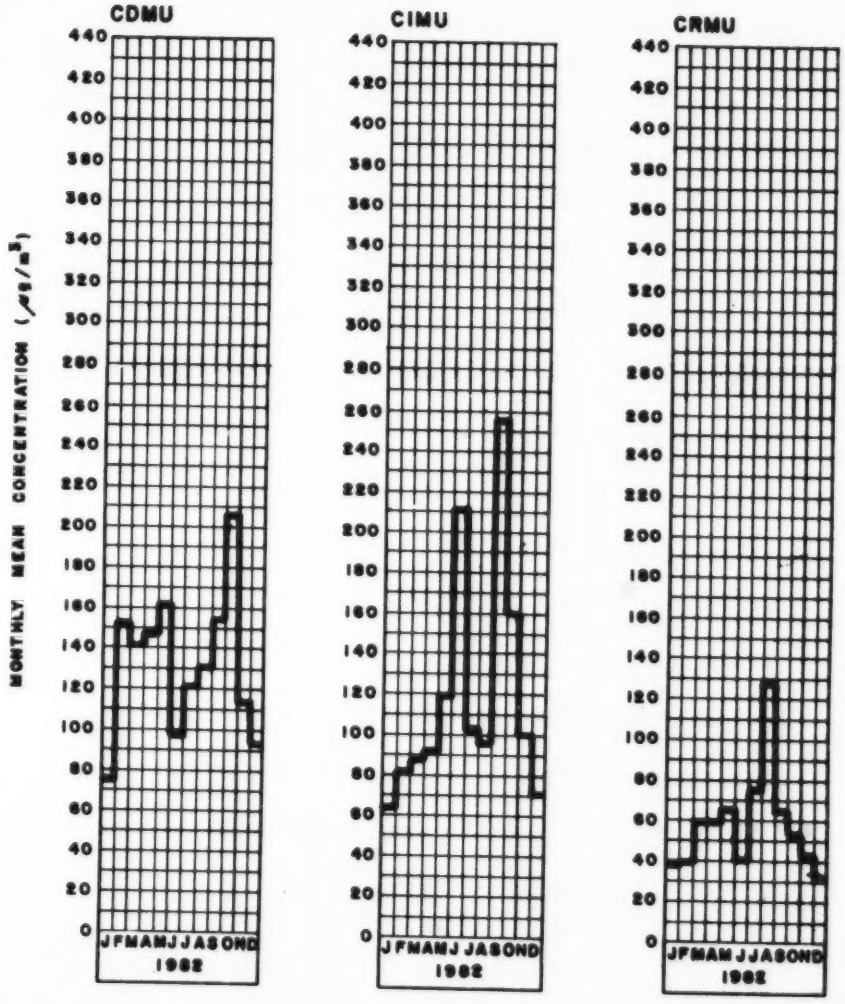
TABLE 15
SUSPENDED PARTICULATE MATTER/HIGH-VOLUME SAMPLER

MAXIMUM LEVELS REGULATIONS
24-HOUR-100 $\mu g/m^3$

MONTH	ARITHMETIC MEAN ($\mu g/m^3$)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATION
		CDMU	
January '82	77	100	100
February	153	100	20
March	141	100	20
April	148	100	20
May	162	100	40
June	98	100	40
July	121	100	40
August	131	100	20
September	155	80	25
October	207	100	0
November	114	100	40
December	94	100	67
		CIMU	
January '82	64	100	100
February	82	100	60
March	87	100	80
April	92	100	60
May	119	100	60
June	211	100	20
July	104	100	40
August	96	100	40
September	256	100	40
October	160	100	40
November	100	100	40
December	71	100	83
		CRMU	
January '82	38	100	100
February	39	80	100
March	59	100	100
April	59	100	80
May	65	100	80
June	40	100	100
July	75	100	60
August	128	100	40
September	65	100	80
October	54	100	100
November	44	100	100
December	32	100	100

FIGURE 14 - SUSPENDED PARTICULATE MATTER: HIGH - VOLUME SAMPLER

MONTHLY MEANS



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ENVIRONMENT
Pollution Control Division

H.3. TOTAL DUSTFALL

Total dustfall includes particles in the size range greater than 10 μ. Since these particles have appreciable settling capabilities, they are collected by deposition in a dustfall jar or cylinder. The dustfall cylinders are generally exposed for 30-day periods and yield integrated dustfall values for that period.

The large particles collected by dustfall cylinders settle readily at low velocities. Therefore, total dustfall cylinders provide a measure of dust arising from local sources. Quite often high dustfall levels are attributable to nearby construction or vehicular traffic on a dusty road.

The results of the monitoring of total dustfall during the 1982 report period are presented in Table 16 and Figure 15. The readings are actual measured levels and are not corrected for "normal background levels." The data indicates that the lowest levels were monitored during the fall and winter months at both the residential-recreational area stations, and the commercial-industrial area stations.

When the total dustfall levels are compared with the Clean Air (Maximum Levels) Regulations, which distinguish between residential-recreational (53 mg/100 cm^2/30 days) and commercial-industrial (158 mg/100 cm^2/30 days) areas, a high frequency of readings in excess of the Regulations is noted in the residential-recreational areas.

There were averages of 73.4% compliance and 86.7% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 16
TOTAL DUSTFALL

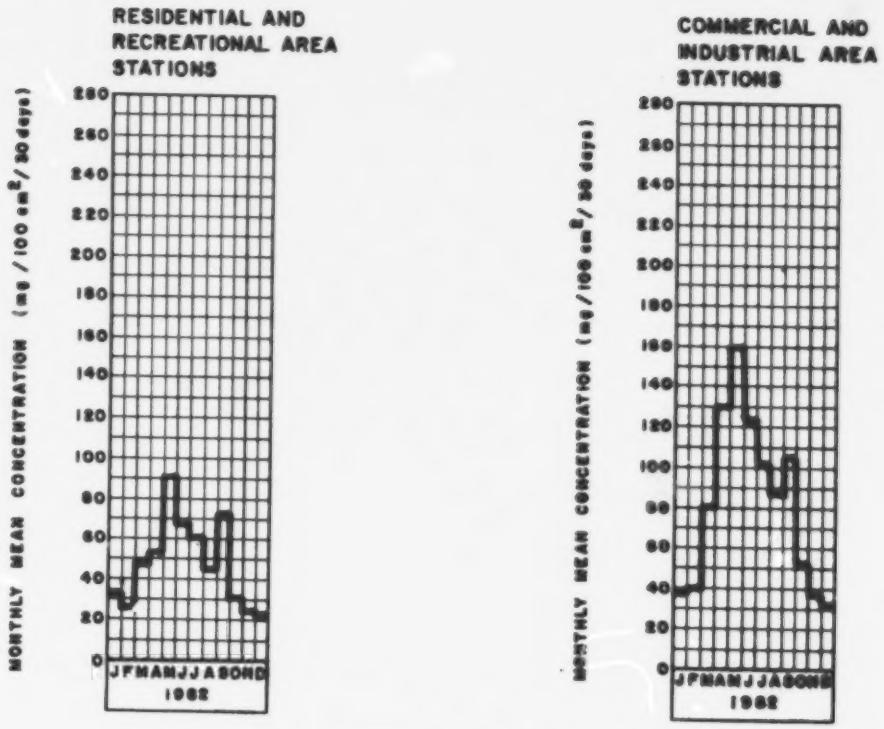
MAXIMUM LEVELS REGULATIONS
53 mg/100 cm^2/30 days in residential and recreational areas.
158 mg/100 cm^2/30 days in commercial and industrial areas.

MONTH	ARITHMETIC MEAN (mg/100 cm^2 /30 days)	PERCENTAGE OF STATIONS REPORTING DATA	PERCENTAGE OF STATIONS IN COMPLIANCE WITH REGULATION
RESIDENTIAL AND RECREATIONAL AREA STATIONS			
January '82	34	100	100
February	26	88	100
March	48	94	75
April	54	94	69
May	91	100	18
June	68	82	43
July	61	88	47
August	45	100	71
September	73	94	62
October	31	100	94
November	25	88	100
December	23	100	100
COMMERCIAL AND INDUSTRIAL AREA STATIONS			
January '82	38	100	100
February	40	91	100
March	81	100	91
April	130	82	78
May	160	91	60
June	123	82	78
July	102	91	80
August	87	82	78
September	106	82	78
October	53	82	100
November	38	82	100
December	34[a]	63	100

a - Instrument operational less than 75%; monthly mean may not be representative.

FIGURE 15 - TOTAL DUSTFALL

MONTHLY MEANS



V. INDEX OF THE QUALITY OF THE AIR (IQUA)

The IQUA is an indicator of the status of existing air quality. It is based on the 1-hour and 24-hour concentrations of nitrogen dioxide, sulphur dioxide, and soiling index (COH), on the 1-hour and 8-hour concentrations of carbon monoxide, and on the 1-hour concentrations of ozone. An index is calculated for each of the five pollutants. The maximum index is then used as the numerical value of IQUA. An IQUA reading of 0-25 indicates good air quality, 26-50 is fair, 51-100 is poor and greater than 100 is very poor.

In Calgary, the IQUA is calculated at three locations: CDMU, CRMU and CIMU, with the index made available to the media and public routinely. It is generally issued at 0800 and 1600 hours on weekdays, except when the index values are greater than 50. In the latter case, it is generally issued every hour until the index value falls below 50.

A summary of the air quality indices for the three monitoring stations is presented in Table 17. During the report year, the air quality was generally good (0-25 as an arithmetic mean). On occasion, however, index values in the 'poor' and 'very poor' categories were observed especially during the fall and winter at CDMU and CIMU. Such values were usually a result of high soiling index levels.

TABLE 17

INDEX OF THE QUALITY OF THE AIR (IQUA)

	CDMU	CIMU	CRMU
MONTH	ARITHMETIC MEAN	ARITHMETIC MEAN	ARITHMETIC MEAN
January '82	23	20	14
February	26	22	14
March	25	18	17
April	21	19	19
May	21	19	19
June	24	19	18
July	21	16	15
August	21	16	14
September	24	20	11
October	27	22	13
November	31	26	18
December	28	22	15

Alberta
ENVIRONMENT
Pollution Control Division
Air Quality Control Branch

VI. SUMMARY AND CONCLUSIONS

From the foregoing analysis of the data, the following can be concluded:

1. During the report year the air quality index in the Calgary area was generally in the "good" range (0-25 as an arithmetic mean).
2. All nitrogen dioxide readings were 100% in compliance with the Regulations, with the exception of 99.9% compliance and 96.5% compliance in November with the 1-hour and 24-hour Regulations respectively at CDMU, and 99.9% compliance with the 1-hour Regulation at CIMU in November and December. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
3. High natural background ozone levels in Alberta resulted in a significant number of readings in excess of the 24-hour ozone Regulation. There was an average of 77.4% compliance with the 24-hour ozone Regulation for all three monitoring stations for the report year. Good compliance was achieved with the 1-hour ozone Regulation (average of 99.95% compliance for all three monitoring stations for the report year).
4. There were averages of 99.8% compliance and 99.1% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
5. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

6. All soiling index (coefficient of haze-COH) readings were 100% in compliance with the Alberta guideline, with the exception of November at CDMU and CIMU.

7. There was an average of 59.7% compliance achieved with the Regulation for suspended particulate matter (0.1 μ to 10 μ size range), averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

8. There were averages of 73.4% compliance and 86.7% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

9. Considering data from 1974 to 1982,

   a) no apparent significant trends were found for nitrogen dioxide and carbon monoxide at CDMU, or for soiling index (coefficient of haze) at CRMU.

   b) upward trends were found for soiling index at both CDMU and CIMU.

   c) downward trends were found for nitrogen dioxide at CRMU and CIMU, for ozone at all three stations, and for carbon monoxide at CRMU and CIMU.

VII. REFERENCES

1. Davis, J.C. "Statistics and Data Analysis for Geology" (John Wiley & Sons Inc., 1973); p. 223.

2. California Air Resources Board, Technical Services Division. "Air Quality Trends in the South Coast Air Basin Through 1979". (Analysis and Projects Section, Meteorology Section, Aerometric Analysis Branch, February 1980).

3. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Nitrogen Oxides. (NAPCA Publication No. AP-84. Washington, D.C., January 1971); sec. 11, p. 8.

4. Alberta Environment, Research Secretariat. A Study of Photochemical Air Pollutants in the Urban Airsheds of Edmonton and Calgary, by H. S. Sandhu. (Staff Report #1. Edmonton, Alberta, 1975).

5. Alberta Environment. Industrial Sulphur Emissions for Alberta 1977-1981, prepared by Alberta Environment, Pollution Control Division, Air Quality Control Branch. September 1982.

6. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Particulate Matter. (NAPCA Publication No. AP-49. Washington, D.C., January 1969); p. 181.